APPENDIX K

EXPLOSIVE METHODOLOGY & ANALYSIS

FAIRWEATHER

PACIFIC, LLC

ATLANTIC RICHFIELD COMPANY (ARCO)

REVISED PRC-421 PIER REMOVAL PROJECT

EXPLOSIVE METHODOLOGY

&

ANALYSIS

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Explosive Design –The proposed use of explosives for severing the pier columns at the sea floor is primarily for personnel safety reasons. Due to the weight of the columns and the dynamics involved with underwater cutting operations and load stability it has been determined that conventional cutting methods could not be safely conducted. The use of explosives will allow safe pile shearing at the sea floor from a remote and protected location. The columns will be allowed to topple after shearing to avoid dynamic shock loads on the lifting equipment. The toppled columns will then be recovered in a more static and controlled environment.

Two methods of severing the columns by explosives were reviewed, one was an internal method and the other was external pile shearing.

In the internal method, core holes are drilled along side the web in the H piles, one on each side of the web to a point at or near the sea floor. This process requires eight core holes to be drilled with a track drill device for each column. Liquid nitro-methane charges would then be lowered into each hole and connected together to allow for simultaneous detonation of all charges. The process would require eight 6.25# charges to equal the estimated 50# TNT equivalent charge required to completely sever the column at the sea floor.

In the external method, the H piles would be exposed just below the sea floor at a point below the base of the grout and the template. External shaped charges containing 1.8# of nitro-methane would be placed around each of the four exposed H piles. The two shoreward charges would be place approximately one foot lower than the seaward charges in an effort to force the column, with help from the prevailing tide and wave action, to fall toward the shore and away from the remaining structure. The charges would be detonated simultaneously. The process would require a 7.2# TNT equivalent charge to completely sever all four H piles.

Comparison of Methods –Both methods described above are proven and sound underwater demolition solutions, however, when compared to each other in terms of environmental effect, controllability, underwater blast wave effect, and overall cost the external method proves far superior. Figure 16 graphically shows the difference in the two methods. As can be seen, the internal method will result in an uneven blast in all directions from each charge. This will basically rupture the concrete from the inside and result in a pressure wave that will tear the H piles in an uneven fashion and leave a large crater at the base of the column. The columns themselves will be ruptured to the point that recovery with the derrick barge will be difficult due to the uneven size and shape of the remaining column. The resulting concrete ruble pile will then have to be recovered, adding overall cost to the project.

By contrast, the external method will result in a controlled shearing of only the H piles and allow the column to topple. This method should not materially add to the size of the hole jetted in the sea floor to allow charge placement and will allow for planned placement of rigging for column recovery due to the fact that the shape of the column should not be materially compromised. Additional benefits of this method include the likely absence of significant concrete rubble to recover as well as minimal underwater blast wave effects.

Underwater Blast Wave Analysis – The table in Figure 17 shows the underwater blast wave effects of both the internal and external method in terms of peak pressure and incident specific impulse effects at several distances from the charge location. As can be seen by the table, the external method would result in the least potential disturbance to adjacent structures, vessels or any marine mammals or fish that might stray into the blast area.

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COLUMN REMOVAL OPTIONS

Internal Blast Method

8-6.25# charges or 50# Nitro-Methane

External Blast Method

4-1.8# charges or 7.2# Nitro Methane

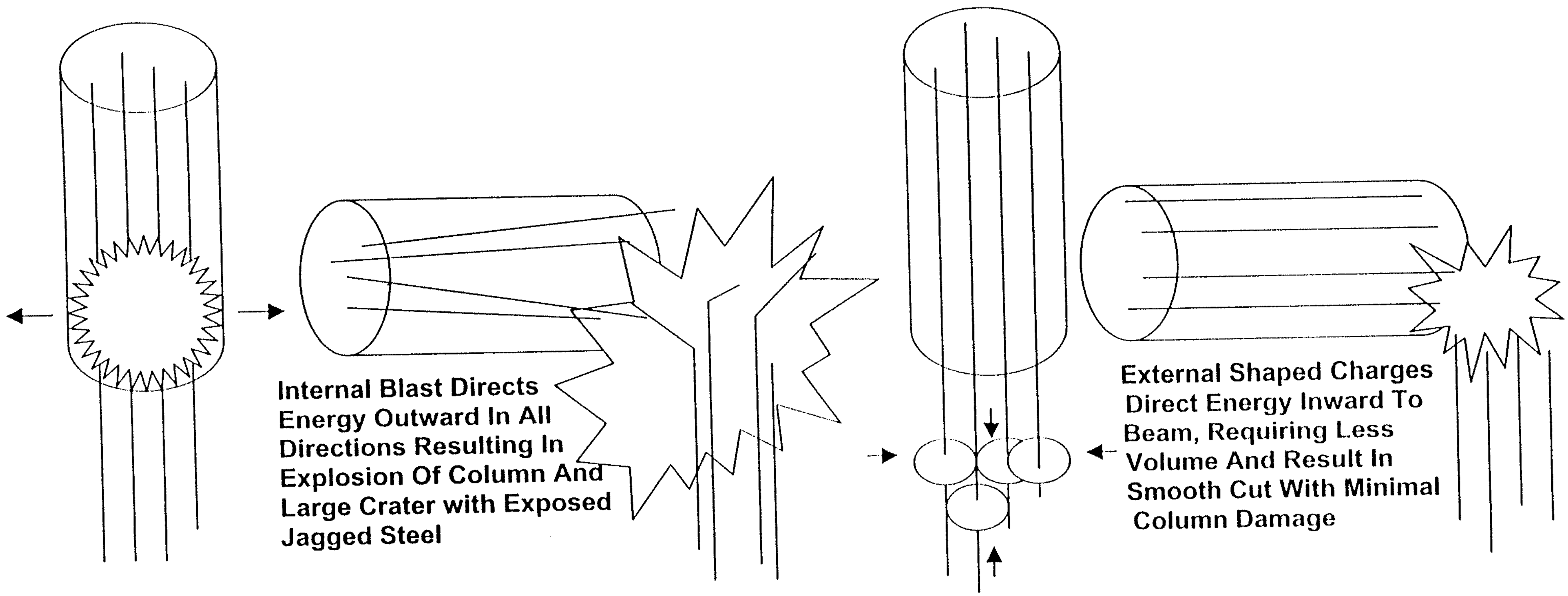

FIGURE 16

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EXPLOSIVE EFFECTS ANALYSIS

Underwater blast wave effects from a 7.2 lb. TNT equivalent liquid severing charge

Receiver Distance (ft)	Peak Pressure (psi)	Incident Specific Impulse (psi-s)*	Time Constant (ms)
100	80.8	0.022	0.278
150	50	0.014	0.286
200	35.6	0.01	0.292
250	27.4	0.008	0.296
300	22.1	0.007	0.3
400	15.7	0.005	0.306

Underwater blast wave effects from a 50 lb. TNT equivalent liquid severing charge

Receiver Distance (ft)	Peak Pressure (psi)	Incident Specific Impulse (psi-s)*	Time Constant (ms)
100	173.1	0.088	0.507
150	107.3	0.056	0.522
200	76.4	0.041	0.533
250	58.7	0.032	0.541
300	47.3	0.026	0.548
400	33.7	0.019	0.559

* The incident specific impulse, used to investigate how ductile structures respond to a very rapidly decaying dynamic load, is the area under the pressure-time curve for an exponentially decaying underwater blast wave.
The magnitudes listed on the upper chart are well below damage thresholds for structures of concern.

Source: Dr. Dave Leidel, Jet Research Center, Alvarado, TX

FIGURE 17